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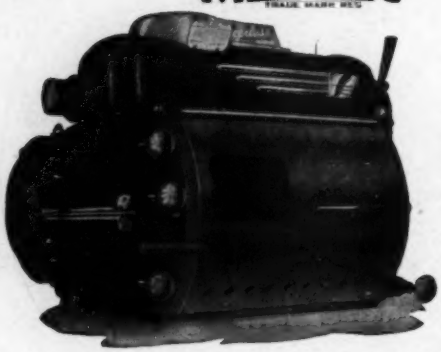

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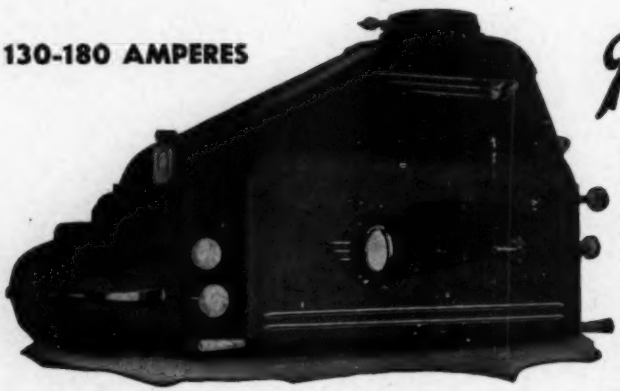

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HENRY B. SELLWOOD, *Editor*

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MONTHLY CHAT

THE motion picture theatre—and the whole pattern of making, distributing and showing motion pictures as we have known it to date—is embarking upon its most crucial season from the standpoint of competition for the entertainment dollar. Much more is involved in this situation than the dollars invested in studios, theatres and other facilities: the major stake is the livelihoods of thousands of workers who have been placed in a precarious position largely through the ineptness, the timidity and the downright ignorance of the so-called executive brains of the industry.

Not a new theme for this department, but a story ever new and growing more important with every passing day.

Time and again we have cited in this corner the several technological advances which, if promptly and properly utilized, would have placed in a deep shadow the current "Movietime, U. S. A." drive as a builder of box-office receipts. Exert the major effort *inside*, not outside, the theatre walls. The glamour of personal appearances and thousands of lines of cheery advertising copy is of a strictly transitory nature. They still pay off for that which is shown on the screen.

We're all for such promotional efforts as the Movietime, U.S.A. campaign now in full swing. But the same type of campaign that promoted such technological advances as three-dimensional motion pictures (*without the aid of individual viewing aids*); truly stereophonic sound reproduction, and vastly improved color processes (the list is not all-inclusive) would, we think, be infinitely more effective and certainly of more *lasting* benefit, than any trans-continental trek by a raft of glamour-pusses. Imagine—more than $2½ million for a campaign that has for its objective inducing people to go to movie theatres—to see that very same entertainment which has been readily available for years past. Now, just imagine if, instead of selling glamour, we had the aforementioned technological advances to sell—permanently, night after night!

If we asked the industry Brass for $2½ million to perfect any one or all of such technological aids to the showing of better motion pictures, they'd likely freeze into utter speechlessness. Still, just one of these birds managed to collect $900,000 *salary*, exclusive of expense money, within one year!

We confess that we don't know what can be done about such a ludicrous situation; but we do know that no Movietime, U. S. A. campaign, of whatever magnitude, could ever provide a box-office stimulant comparable to that which is readily available *right now* to every theatre in the land. The making, the showing and the *selling* of motion pictures to the public depends almost wholly on the technical excellence of the product—that which hits the screen and reaches the ears.

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VOLUME XXVI SEPTEMBER 1951 NUMBER 9

The Magic of Color

By ROBERT A. MITCHELL

V. (Conclusion)

The Projection of Color Films

COLOR and the various methods of making movies in natural color were described in the preceding installments. Now, in conclusion, let us direct attention to the *projection* of color films. *This* is our metiér. The advantages of filming theatrical motion pictures in natural color are multifarious and self-evident. Some of these advantages are all but lost, however, when the technique of screening color films is faulty.

The quality of projection depends primarily upon the condition of the projection equipment, of course; but there are also other important factors to be considered. If, for example, the prints are bad, or if the projectionist is careless in his work, or if conditions in the auditorium are unfavorable to the best screen results, not even the best equipment can give quality performance.

Technicolor is very "fussy" anent conditions under which its prints are projected—justifiably so—and no effort, no expense is spared to insure quality prints. But it is entirely possible to follow meticulously Technicolor's instructions regarding auditorium lighting, the burning-in of new carbon trims, checking the focus, *etc.*, and still obtain poor color pictures on the screen.

Equipment Condition Governs

The condition of the projection equipment is the governing factor. One can't project good color with low-intensity lamps, uncoated projection lenses, and old-style projector shutters—color quality notwithstanding. The use of obsolete equipment is like playing a modern electrically-recorded phonograph record on a 1910 gramophone.

Low-intensity (L-I) lamps may be acceptable for the projection of black-and-white prints, providing the arcs are bright enough (which they seldom are), and providing the exhibitor just doesn't give a damn about screen image quality.

Technicolor prints are balanced in color value for high-intensity (H-I) lighting. L-I arcs have too low a color temperature for the faithful reproduction of colored prints—too yellowish and thus dull all the blues, violets, purples, and purplish reds in the picture. And don't let anyone tell you that the public tolerates a wide divergence from true color values "when there is no standard of comparison." The writer can see the alteration of hue when an amber-tinted print is projected *via* L-I or H-I lighting. You can, too, and so can the average movie-goer. These facts should be seriously pondered in view of the present widespread use of natural color.

'Hot Spot' Screen Effect

Even H-I lighting is not faultless. It's the old, old story of "hot-spot." How can one possibly get good colors near the edges and corners of the screen if the lamps can do no better than 60- to 80% side-to-center light distribution? It just can't be done.

Yellowish-green turns to an olive shade at the edges of the screen when light distribution is not uniform. Red changes to terra-cotta; blue to a steel-gray; orange to brown; and yellow to a shade too unpleasant to be described. If variations in the color of the projected light accompany the variations in intensity (usually) faces will appear unnatural, and other weird color effects will be produced.

Here is a test which is not so rough but that it will give a fairly good idea of the quality of light-distribution delivered by the lamps.

Project light to the screen—projector running but without film. By means of the mirror knobs, move the spot from side to side or up and down as rapidly as possible. If a "hot-spot" is present, this test will reveal it immediately—no doubt about it. You will actually see the bright center of the illumination-field moving horizontally or vertically on the screen. It is the *movement* of the field of light on the screen which shows up the hot-spot so *plainly*.

Over-All Screen Brightness

If you find a trace of a "hot-spot" notify the manager: he has a right to know the facts about such conditions. Lumens are cheap, but uniform illumination is a rare bird. This is a fact which every exhibitor who wants his money's worth should remember when purchasing new lamp equipment.

Over-all picture brightness is also an important factor in the projection of color films. Colors and their proper contrast values as photographed on the film

appear natural only when the screen illumination lies within certain very definite limits. To be more exact, the brightness of the illuminated screen *as seen by the audience* should be specified.

For example, the intensity of the projection light falling upon the surface of the screen is measured in foot-candles (ft-c). Now, it is commonly assumed that a minimum of 10 ft-c is necessary for the satisfactory projection of films in natural color. This recommendation does not take into account the degree of whiteness (the reflectance) of the screen, however. A screen besmirched with tattle-gray will not give as bright a picture under 10 ft-c as a new or freshly surfaced screen.

Screen Reflecting Power

Table A lists the approximate reflectances (as percentages) of both perforated and solid matte screens—average, new, and old. This table will give an idea of the reflecting power of your screen, provided you are not using a beaded or aluminum-surfaced screen.

Even a new screen, if it be soiled, is just as bad as an old screen. Screens "age" much faster in cities than in small towns because smoke, dust, and several kinds of chemical fumes are usually present in the air of cities.

The best white bond writing-paper reflects from 65 to 70% of the light falling upon it. It is possible, therefore, to judge approximately the condition of any mate screen by comparing its whiteness with that of fresh writing paper. But if the comparison be made on the stage, 10% must be subtracted because the sound perforations occupy about 10% of the total area of the screen.

Calculated in Foot-Lamberts

It can therefore be appreciated that a specification of ft-c of projection light at the screen cannot tell how bright the picture will appear to the audience. Instead of *foot-candles* (intensity of light from the projector running without film, measured at the screen), the brightness must be specified in *foot-lamberts (ft-L)*.

If a screen has a reflectance of 100%, 10 ft-c would furnish a screen brightness of 10 ft-L. No matte screen, however, even if "solid," is able to reflect *all* the light falling upon it. In fact, a brand-new unperforated matte screen does well to reflect even as much as 80% of the light. By using such a screen, 10 ft-c of projection light at the screen results in a screen brightness of only 8 ft-L—not quite enough for top-notch results with color films.

TABLE A
APPROXIMATE REFLECTANCE OF MATTE SCREENS

TYPE OF SCREEN	AVERAGE	NEW	OLD
Perforated	54%	72%	36%
Solid	60%	80%	40%

The best opinion is that screen brightness should not be less than 10 nor more than 20 ft-L for the projection of modern theater-release prints, including natural-color films, such as Technicolor.

Table B gives the ft-c-ratings (measured at the screen with projector running, but without film) required to furnish 10, 15, and 20 ft-L of screen brightness for perforated and solid matte screens—average, new, and old.

Maintaining Spectral Balance

It seems almost unnecessary to add that an old, soiled screen is very likely to be yellowish in color, besides having poor reflective power. A yellowed screen gives exactly the same color-distorting effects of L-I projection. Yet many exhibitors, apparently expecting their projectionists to perform miracles, postpone the purchase of fresh, white screens capable of reflecting all of the colors in proper spectral balance.

Although considerable latitude in screen brightness is allowed, the hues in a Technicolor picture actually shift slightly in the hue scale if the illumination is too faint or too intense. These changes are caused by the Purkinje (pronounced *poor-keen-ya*) effect.

If the picture is too dim, bright red assumes a slightly magenta cast, orange becomes brick-red, orange-yellow becomes brown, bright yellow appears khaki-colored, and the blues and purples "wash out" to gray. Only the greens appear normal. On the other hand, if the picture be too bright, the reds, oranges and the yellows appear too intense in comparison with the greens; and blue looks slightly violet. Moreover, the deepest blacks in Technicolor prints have sufficient red transmission to actually look red on the screen when too much screen illumination is used.

Too Little, Too Much Light

Then, too, detail in the shadows is lost when the picture is too dim; while a terrific shutter-flicker becomes visible when the picture is too bright. Flicker caused by the rotating shutter (48 cutoffs per second) would not be a problem if we had 5-to-1 intermittents (such as the Powers pin-cross movement) thus permitting 3 shutter cutoffs per frame instead of 2.

Shutter flicker is especially annoying to patrons seated in the front rows because averted vision does not have as much "persistence" as does direct vision. You cannot help but see the flickering of the light when the screen subtends a large angle of the visual field.

TABLE B
FOOT-CANDLES TO FURNISH 10, 15 AND 20 FOOT-LAMBERTS

TYPE OF MATTE SCREEN	FOOT-LAMBERTS		
	10	15	20
Perforated:			
Average	18.5	27.8	37.0
New	13.9	20.8	27.8
Old	27.8	41.7	55.6
Solid:			
Average	16.7	25.0	33.3
New	12.5	18.8	25.0
Old	25.0	37.5	50.0

A picture which is both too big and too bright therefore makes the front rows of seats less useful to the exhibitor than other seats. Everyone except the kids (who want to see the picture BIG at any cost) avoids the "down-front" seats. Exhibitors would find their seats nearer the screen increasing in popularity by using projectors having 5-to-1 intermittents and 3-blade shutters (72 cutoffs per second), for these would permit bigger and brighter pictures with less flicker. At present, however, such machines are not to be had for love nor money, and only the projector manufacturers know why.

We all know that these machines can be made at no increase in cost.

Auxiliary Lighting Effects

Technicolor warns us not to use colored lighting on or near the screen during the showing of Technicolor films, and also to eliminate red and amber decorative lighting in the auditorium. These suggestions are well-founded.

Color-flooding the titles of Technicolor productions, either by projecting the titles on a colored curtain or by using colored foot- and strip-lights, is bad practice because Technicolor titles are designed with artistic care. Color-flooding alters the colors recorded on the film—colors which not only make the titles pleasing to see, but which harmonize the titles with the dramatic mood of the picture to follow.

Nearly every projectionist has color-flooded titles at one time or another. In the case of black-and-white films, the effects obtained are often very pleasing and in good taste: they "dress up" the show and provide an extra note of that glamour to which the motion picture industry owes its very existence.

The titles of comedy-romances and serious dramas, for instance, might advantageously be flooded with pink-ma-

(*Continued on page 30*)

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The Scientific Basis for Establishing Brightness of Motion Picture Screens†

By FREDERICK J. KOLB, Jr.

The appended report covers a round-table discussion initiated by Dr. W. W. Lozier, chairman of the SMPTE Screen Brightness Committee. The conference was held at Rochester, N. Y., thus as a matter of expediency only men available there were asked to participate. Participating in the discussion were the following men, all actively engaged in the fields of projection optics and psychology:

DR. LOZIER, National Carbon Co.; from various departments of Eastman Kodak Co.: G. A. CHAMBERS, Motion Picture Film; R. M. EVANS, Color Contrast; D. F. LYMAN, Camera Works; S. M. NEWHALL, Color Contrast; OTTO SANDVIK, Research; K. F. WEAVER, Research; F. J. KOLB, JR., Engineering Experiments; and D. WOOD, Camera Works. Also, from the University of Rochester: BRIAN O'BRIEN, Institute of Optics, and S. D. S. SPRAGG, Department of Psychology.

DR. LOZIER reviewed the background for this discussion by noting that a "temporary standard" for the brightness of motion picture screens was adopted by the Society in 1938, after the available data had been summarized. Slight modification was made in 1944, but actually the interval from 1936 to the present has been characterized by the accumulation of considerable fundamental information without the opportunity for consolidating the data, or for the Screen Brightness Committee to consider modification of the temporary standard.

The present standard for screen brightness (Z22.39—1944), Lozier pointed out, specifies "the brightness at the center of a screen for viewing 35-mm motion pictures shall be 10 ft-L (foot-lamberts) (+4 or —1 ft-L) when the projector is running with no film in the gate."

Origin of the Standard

In discussing the present standard, Lozier pointed out the work culminating in the SMPE symposium of 1935-36 which led to the adoption of a screen brightness standard. The Committee report, relying upon the survey of technical knowledge presented in the symposium, discussed, first, the desirable levels of screen illumination, and second, attainable levels. The fundamental data of physiological optics were not directly applicable to the problem at that time, the Committee concluded, because the work had not been complete enough to permit the prediction of response under theater viewing conditions. Instead, consideration was given to the more practical experiments.

From these observations the Committee concluded that an ideal brightness level probably should be something in the order of 30 ft-L, and that a peripheral brightness of the order of 0.05 ft-L would be desirable at this brightness level.

Properties of Release Prints

Considering next the properties of release prints, the Committee decided that very little change in print density can be expected since: (1) Release prints can be made no more transparent because of the limitations of the existing photographic materials; lighter printing would endanger tone reproduction in the highlights. (2) It would not be practical to increase print density, since an increase of about 0.15 in density would be necessary to place the highlight density of release prints nearer to the straight-line portion of the characteristic curve for positive film: one might thereby improve tone reproduction, but only at the expense of a necessary increase in illumination approximating 40% to maintain equal apparent brightness.

For the slight advantage offered, this shift in print density (probably requiring a reduction in screen size to maintain picture brightness) was judged impractical.

Considering then what screen brightnesses might be possible with existing equipment, the Committee concluded that for a 30-ft screen an attainable brightness of about 7 ft-L would be the maximum. In order to reduce the discrepancy among theaters, and between theaters and review rooms, the Committee decided that a temporary standard on the basis of attainable brightness would have the advantage of stimulating an over-all improvement in picture quality.

Set 7 ft-L as Minimum

Therefore, assuming that a 30-ft screen might be the maximum size which the Society should attempt to recognize, the Committee decided that the minimum acceptable screen brightness should be 7ft-L.

In order to choose an upper limit the Committee attempted to determine what range of brightness could be tolerated without an objectionable change in the apparent contrast of the picture. It was considered undesirable to set the upper limit at 30 ft-L, since this would result in an excessive spread in screen brightnesses among the various theaters. On the basis of available data, the Committee selected a maximum value of screen brightness such that the predicted apparent change in contrast would be 15% between the average and either extreme (for picture densities corresponding either to the average of the whole frame, or to the area of principal interest).

Modification of Standard

Summarizing its recommendations, the Committee said, "The value 7 is based upon the value attainable for a diffusing screen about 30 ft. wide with an efficient optical system in good adjustment. The value 14 is the limiting value beyond which print contrast adjusted for the mean level of 10 ft-L will appear too great. The value should be determined at the center of the screen, with a projector running, with no film in the gate."

Subsequently, the Screen Brightness Committee suggested a modification in this standard from 7-14 ft-L to 9-14 ft-L

TABLE I

	Print Density			Screen Brightness, ft-L		
	Min.	Mean	Max.	Max.	Mean	Min.
Average of entire frame	0.67	1.15	1.90	2.1	0.71	0.13
"Face" or area of principal interest	0.60	0.99	1.60	2.5	1.0	0.25
Brightest highlight	0.19	0.43	0.90	6.5	3.7	1.3
Deepest shadow	1.87	2.40	3.20	0.13	0.040	0.0063

Highest scene contrast = 2.45 Lowest scene contrast = 1.38

†J. Soc. Mot. Pict. & Tv Eng., April, 1951

in 1941; the revised standard was adopted by the ASA in 1944.

'Actual' Picture Brightness

It should be emphasized especially for those not used to motion picture practice that the screen brightness as specified by the standard is markedly reduced when there is film in the projector and a picture on the screen. Assuming the available data to be approximately correct for the fine-grain print stock now generally used, *actual picture brightnesses* for a "screen brightness" of 10 ft-L would be as shown in Table I.

The problems of screen brightness for both 35-mm and 16-mm are generally similar, and 16-mm practice has tended to follow the 35-mm standard. It is usual, however, to permit a higher variation from the average brightness in 16-mm installations.

Recent Investigational Work

Since the 1936 symposium there has been considerable discussion and some additional work pertinent to the setting of a suitable screen-brightness standard. Reeb reported results of an experimental study in Germany, investigating the contrast sensitivity of the eye under conditions similar to those found in viewing motion pictures.

The German investigators concluded that maximum contrast sensitivity occurs at about 14 ft-L, that only the central brightness is important in attaining visual effect, that rapid changes in brightness of a scene do not affect sensitivity, and that screen areas of varying sizes do not cause different brightness impressions. From this it was concluded that the optimum brightness level would be 14 ft-L with the improvement being gradual beyond 8 ft-L.

The German investigators further proposed that standardization would be incomplete without specification of the permissable drop of brightness with angle of view, since directional screens are becoming important.

A British survey examined visibility of grain, appearance of flicker and glare, and also tabulated specific comments on individual subjects and on the general quality of projection. From these data curves were prepared from which the Committee concluded that screen brightnesses should conform to the following:

Subject	Min.	Max.
Black-and-White ..	12 ft-L	24 ft-L
Technicolor	7 ft-L	14 ft-L

As a summary recommendation, the Committee proposed a minimum screen brightness of 8 ft-L and a maximum of 16 ft-L, and this has been adopted as British Standard 1404.

Further discussions have been published, but it does not seem that they offer any additional basic data suitable for the further analysis of this particular problem. In many cases, however, they provide excellent summaries of the data available and of the practical application of the data, and of standards and recommendations.

Temporary Nature of Standard

In the report of the Projection Screen Brightness Committee in 1936, it was emphasized that their recommendation was for a tentative standard, to be modified as soon as practical: "It appears to the Committee .... that the industry might stand to benefit by the adoption of a temporary screen-brightness standard. Logical limits for such a standard would appear to be 7 ft-L for the low value and 14 for the high value."

In its discussion, the Committee concluded that, on the other hand, an ideal standard "should be something of the order of 30 ft-L and that a peripheral brightness of the order of 0.05 ft-L is desirable at this brightness level. If such a brightness were obtainable, logical brightness limits would be 20 ft-L minimum and 45 ft-L maximal."

Having thus proposed a temporary standard, the Committee listed some of the questions which should be answered in order that the temporary standard might be replaced by an operating standard closer to the ideal range of screen brightness. These questions, promulgated in 1936, follow:

Basic Questions Posed

1. What correlation is there between best print contrast and screen brightness?

2. What effect does the brightness standard have upon the standard of release print quality? Shall release prints of different contrasts be made available to theaters operating at different screen-brightness levels? (Any work done on the standard release print must, for obvious reasons, consider the screen-brightness standard if it is adopted.)

3. Is highlight density, average density, density of the area of principal interest, or a combination of these factors, the thing that determines preferred brightness?

4. What possibilities are there for improvement in projection optics, pull-down efficiency, and source brilliance?

5. What is the effect of color of the light source, color of the screen, and color of the print upon the desired brightness?

6. What proportion of moving picture goers see pictures on screen greater than 20 ft, 25 ft, 30 ft? Statistical data on theater sizes, screen sizes, projection equipment and attendance figures are needed. A complete paper of this kind would be valuable also in connection with other problems confronting the Society.

7. What factors determine screen width? Would it not be better, for instance, to use a 25-ft screen at 9 ft-L than a 30-ft screen at 7 ft-L? The data of visual acuity tell us that the picture detail visible at great viewing distances should not suffer.

8. What are the possibilities for the development of simple, rugged, and inexpensive brightness-measuring instruments? Cannot a satisfactory simple brightness tester be developed with two fields, one at the higher and one at the lower brightness limit? Could not such an instrument be used easily by the theater projectionist to determine whether he is operating within the recommended brightness range?

9. What is the effect of auditorium illumination upon the required brightness level?

10. What is the effect of the visual angle or the screen size upon this value?

11. What tolerance in nonuniformity of

(*Continued on page 24*)

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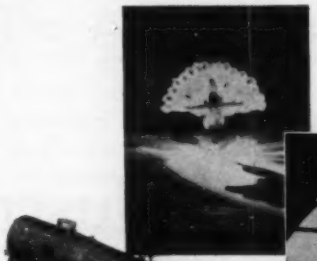
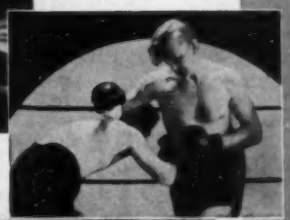
Representatives from all over the world are shown inspecting the new Westrex M4D re-recording and scoring console. Shown here, front row left to right, are E .S. Gregg, vice-president and general manager of Westrex; W. L. Bell (France); R. W. Wight (Hollywood); W. DeMello (Colombia); D. Pollock (South Africa); R. J. Engler (England); R. R. Abarbanell (Philippines); Second row: W. E. Kollmyer (India); J. Cueves (Brazil); O. J. Forest (Trinidad, B. W. I.); M. Storms (Panama); S. Wiedemann (Switzerland); A. C. Leonoel (Algeria).





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The Allied Arts and Sciences

There is a vast field of artistic and scientific endeavor which is directly contributory to the motion picture process and, therefore, to the practice of projection. The true craftsman should have a well-rounded understanding of these contributory factors, particularly in view of the imminent widespread utilization of television and, possibly, stereoscopic pictures and stereophonic sound. To this end, IP here inaugurates a special department which will provide basic information on the aforementioned arts and sciences.

I. Photographic Optics

Bausch & Lomb Optical Company, Rochester, N. Y.

THE optics of photography is customarily looked upon as a subject too difficult for general consumption, and as a consequence the basic factor—the factor without which photography could be but a shadowgraph curiosity—is neglected and left to chance. No wonder, then, that a large mass of hoary misapprehensions has gathered about the optics of the processes.

Here we shall discuss two things—the general conditions underlying image formation, *i.e.*, what the lens designer must do to provide the photographer with good images, and second, practical characteristics of lenses.

We shall see that optics as applied to photography, particularly in its practical aspects, is not remote and theoretical, but built up step-by-step from common experience, and all that is necessary to understand the most essential facts of lens performance is a willingness to learn and an average endowment of common sense.

Meaning of a 'Good Image'

We must first establish in our minds some fundamentals: What is an image? What is meant by a *good* image? How good must an image be?

What is an image? To a physicist or an optician, an image formed by a lens system is the totality of reunion points of light rays emitted from the corresponding points on the object being imaged. Let us translate this statement into English more easily digested.

The object being imaged consists of an indefinite assembly of points each of which is emitting light in accordance with its brightness. To form an image of this object it is necessary to reunite into their corresponding points the light emitted from points of the object.

In this manner the points which are bright in the object will send out a larger quantity of light, which will result in brighter image points, the less brilliant object points being more conservative of light and their corresponding image points likewise. Thus the lens establishes a one-to-one correspondence between object points and image points both for relative brightness and for general location.

Point-for-Point Representation

This, then, almost automatically gives us the conditions to be satisfied by the ideal image,—it must be an accurate point-for-point representation of the object with each part of the image in the proper relation to every other part of the image. Anything which hinders either the reunion of the light rays into points, or disturbs the relationship of the image parts, causes a departure from ideal imagery, and is spoken of as an aberration. A perfect image in the terms here used is never found, for we have been dealing with mathematical concepts, which are only idealizations, while we must live in a somewhat imperfect and practical world.

Because our senses are imperfect, and further, because of the grain in photographic emulsions, we find that we can use rather less than perfection in our lenses, thus making pictorial photography possible by creating depth of field.

Functional Test Fairest

Lest the preceding paragraph seem like a paradox, let us hasten to say that the only fair test of a product is a functional test. If a product satisfies the function for which it was intended, it has fulfilled its intention. Tests usually can be devised to show flaws in the best products. These tests are often artificial and always purposely hypercritical. Photographic lenses can be tested in the same manner.

But what difference does it make, if the flaws seen in an artificial test are invisible in the camera? In other words, if your lens is performing satisfactorily and has given what seem to you to be perfect images, for your purposes you have the perfect lens, in spite of what will be said here. We should of necessity have to split hairs to show the aberrations, for some of them are of very small magnitude in modern lenses.

Because we are not dealing with mathematical perfection but with practical physics, we do not have to demand that our lens yield a mathematical point image. If a disc of about three one thousandths of an inch diameter were presented to the eye at 10 inches, it would be appreciated as a point. To all intents and purposes this disc would be a point, and we have no right to demand less diameter in our final prints.

This disc, of maximum size still perceived as a point, permits the depth of field so necessary to photography, and further allows reasonably satisfactory images from imperfect lenses. How this depth of field through finite image discpoints is accomplished will be seen farther along in our discussion.

The Pinhole Camera

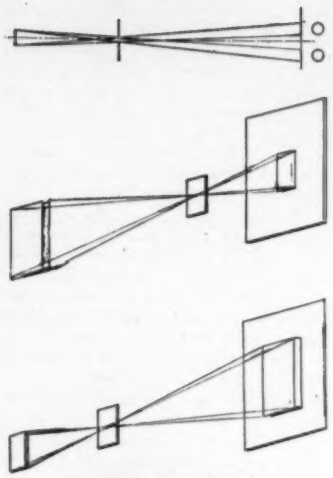
The simplest camera is usually given consideration at the beginnnig of a discussion like this with good reason,—it teaches us much concerning the fundamentals of our subject. Parenthetically, the photographer's education is not complete until he has actually made and used a pinhole camera. It is easy to make, and instructions are readily found.

The principles of the pinhole camera are well illustrated in the diagram. Each point of the object emitting light which falls on the camera front creates, in effect, a shadow of that front on the emulsion. The only light actually getting through to the emulsion is that finding the pinhole. This light having come from a point is diverging, and will continue to diverge after passage through the hole, and by the time it reaches the emulsion it will have spread into a disc larger or smaller depending on the distance betwee nthe pinhole and the emulsion, and the size of the pinhole. This disc will then represent the point on the object from which the light originally came, *i.e.*, it will be the pinhole image of that point.

Image-Governing Factors

The collection of overlapping discs will be the image of the whole object. Pinhole imagery is largely pure geometry, as is the formation of images by means of lenses, the geometry being more clearly seen in the case of the former (Fig. 1).

The size of the *image* in a pinhole camera will depend on two factors, just



PINHOLE GEOMETRY
Top to bottom: Figs. 1, 2 and 3.

as in lens camera: the distance of the object, and the distance between the pinhole and the film (Figs. 2-3). The closer the pinhole and film, with a fixed object distance, the smaller the image, *i.e.*, the greater the reduction. The size of the image discs likewise depends in theory upon these factors; however, practically the only factor having effect is the distance between the hole and the film, since the object is usually at virtual infinity.

It is apparent that the size of the pinhole influences the size of the image disc, which we call the *circle of confusion* in accord with standard practice. The larger the pinhole, the larger the circle of confusion, and further, the more light falling on the film, that is, the "faster" the pinholes lens. In fact, the speed may be defined, just as in the case of a lens, by the ratio of the diameter of the hole to the distance from the hole to the screen, and the illumination on the screen will vary as the square of this ratio. (In practice the reciprocal of this ratio is used. It is used here in this manner for purposes of illustration.)

Pinhole Camera Attributes

The pinhole camera possesses several distinct advantages over cameras equipped with lenses: it is of universal focus; everything to infinity is focused on the emulsion; it will give a truly distortionless image, or in scientific language, an *orthoscopic* or angle-true image; it is the perfect wide-angle system, permitting the photography of angular fields practically unattainable with lenses; and, finally, it is so simple anyone can make and use it.

However, the pinhole camera is not a panacea for ills photographic—it is extraordinarily slow compared even with the slowest of lenses, requiring extremely long exposure times; and most important of all, the image leaves something to be desired in the way of sharpness, as is to be expected. This softness of image is not always undesirable, however.

We have seen from the geometry of the pinhole camera that there is a focus of a sort at any separation of the hole from the film, but that the size of the image, *i.e.*, the magnification, is proportional to the distance, in addition to varying inversely with the object-to-pinhole distance.

Two Simple Explanations

The pinhole-to-film distance is the *focal length* of the camera. The focal length of the lens counterpart is defined as *the distance from the equivalent refracting point of the lens to the axial point where parallel rays of light are united.*

In the case of simple, thin lenses such as are used by optometrists, the focal length is closely equal to the distance from the lens to the focal point in parallel light. This, however, is not true for the more complicated lenses we must use in our cameras. The focal length, which determines the magnification, the stop number, and the angle of view of the lens with any particualr film size is called "equivalent focal length," abbreviated E.F., and is perhaps the most important single characteristic distinguishing any one ens from the universe of all possible lenses.

It is found, when lenses become complex, that there are two points on the axis of the system, where equivalent thin lenses can be placed having the same refractive effect as the given system. With these *principal points* in a lens in air coincide a sort of generalized center of the complicated lens or lens system, the *nodal* points which have the property that a ray of light directed toward one will emerge from the other nodal point undeviated.

The E. F. of a Lens

The equivalent focal length of a lens is defined as the distance between the second or emergent principal point and the point on the optical axis where the lens unites a parallel beam of light. In most lenses the distance from the rear surface of the lens to this focal point will be less than the equivalent focal length. This distance is called the "*back focus*" and is the one really measured in a simple lens, where the second nodal point is very close to the lens surface (Fig. 4). In most lenses the nodal points are approximately at the center of the lens at the point where the diaphragm is found.

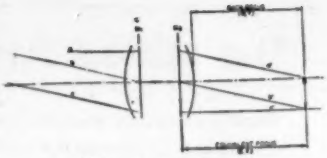


FIG. 4. The thick lens.

For many practical purposes, the diaphragmn position (halfway through the shutter) may be looked on as the center of the lens, and equivalent focal length as the distance from the diaphragn to the emulsion when the lens is focused on infinity. The foregoing statements are true with any lens except a true telephoto, in which the principal points are actually outside the lens, in front.

Earlier we saw that the requirements for ideal image formation were that the rays leaving each point in the object be united in proper relation to the neighboring points. We further said that any disturbance of the orderly reunion of the light rays constituted an aberration. The most important aberrations are seven in number: five so-called third-order aberrations which are independent of color but whose magnitudes vary with different colors, and two pure chromatic aberrations.

Spherical Aberration Data

This is the only monochromatic aberration which can occur on the axis of a well-made lens. It has its origin in the fact that the margins of lenses made with all but certain strange mathematical surfaces have effectively more light bending, or refractive power than the regions near the axis, so that the marginal rays are brought to a focus closer to the lens than the near axial rays.

Surfaces which can bring all rays striking a lens to a common focus are weird mathematical creatures, impractical for the lens grinder to duplicate, and impossible in mass production as yet. The manufacturer prefers to work with spherical surfaces whose complete symmetry he uses to give him accurately reproducible surfaces, thus making possible quantity production of usable lenses.

As this particular aberration cannot be corrected in one lens, two of essentially opposing tendencies must be used to gain relief. We shall see more of the method of correction when we consider chromatic aberration.

Practical Effect of S. A.

Spherical aberration has the practical effect of laying a haze over the sharply defined image of axial points, and is equivalent to a diffusion disc before the lens. As a corollary of this, a lens with considerable spherical aberration will give a soft image, and indeed, some thirty years ago lenses with variable amounts of

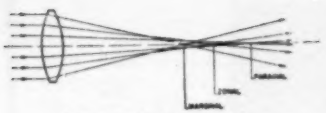
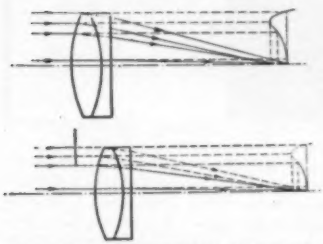


FIG. 5. Spherical aberration.



CORRECTION OF SPHERICAL ABERRATION.
Top to bottom: Figs. 6 and 7.

this aberration were sold as variable soft-focus lenses, and some may even be on the used lens markets today. A further consequence of this aberration is the greater depth of field and of focus, since no one plane is sharply defined (Fig. 5).

Spherical aberration cannot be perfectly corrected—the best that can ever be done is to bring to a common focus the axial rays and the rays passing through some other point on the lens diameter, usually near its periphery. This effects the best compromise correction, and is that most favored (Fig. 6).

This aberration is a function of the aperture of the lens, and will naturally be less, the smaller the stop used. Stopping down the lens will cut out the marginal and zonal rays, leaving the rays which normally would strike the axis closer together. The image would then appear to gain in crispness, while the depth of field increases (Fig. 7).

Spherical aberration is one of the more important of the aberrations, largely under the control of the designer, and usually reduced to a safe magnitude. However, there are lenses in which this aberration is left practically untouched for various reasons. If your lens gives crisp images with the film you normally use, rest assured that the maker has paid due respect to this troublesome aberration.

Coma: Most Important

This is the most important and most annoying single aberration of the whole battery afflicting lenses. Coma is the image destroyer which effects more ruin unaided than any other aberration. Photographic objectives otherwise perfect might have left in them each of the other aberrations singly and still be usable, but if uncorrected coma alone is present in an objective the lens is utterly worthless.

Coma affects only the points in the field of the lens, *i.e.*, the extra axial ponits. In the presence of this aberration those points are drawn into unsymmetrical figures, causing an unsightly blending of detail, and a loss of the possibility of recognition in extreme cases.

The nature of coma can be recognized from a consideration of the diagram (Fig. 8). The ray through the center of the lens is called the principal ray, and strikes the image plane at the point shown. In the presence of coma the rays through the outer zones of the lens do not strike the image plane at the same point as the principal ray. The discrepancies of these points measured in the image plane represent coma.

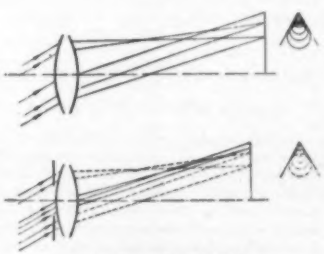
The actual image in pure coma is shown in the illustration. Each circle represents the locus of the foci of rays passing through a corresponding zone of the lens, the larger circles representing the outermost zones, and the vertex the principal ray. Actually the whole patch is not seen, for the figure shades off quite rapidly, and only the form shown in the figure is seen. Even so, it is readily apparent that this aberration deserves the attention given it.

Correction for Coma

Coma is corrected in lens systems by making suitable choice of the curves on the lens surfaces, technically by "bending" the lenses, *i.e.*, by changing the shape of the lenses.

Coma varies with the aperture in the same way as spherical aberration, and stopping the lens has the same effect. This is another reason for the adage, "stop the lens for sharpness." Coma further varies as the image height, which means that it will be worse near the margins of the picture. As the lens is stopped down, obviously light cannot pass through the outer zones and the corresponding image circles are missing, until, at the limit, when but one ray gets through, true point imagery is attained (Fig. 9).

Pure coma is exceedingly rare, and the comatic figures drawn are practically never seen, for this aberration is usually



ILLUSTRATING COMA
Top to bottom: Figs. 8 and 9.

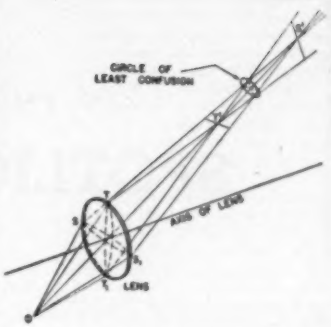


FIG. 10. Astigmatism.

seen together with astigmatism, which leads to peculiarly complicated figures.

Astigmatism: Separated Images

This is one of the strangest of the aberrations, for while the others govern either the shape or position of an image point, this one demonstrates two image positions as definitely separated image lines which are mutually perpendicular and perpendicular to the axis. In the presence of this aberration a point in the object gives rise to two separated images, lines at right angles. This particular aberration is rather frequently seen in photographs.

Better to comprehend this aberration, consider the drawing (Fig. 10). We saw that each point of the object reflects rays which strike the lens or lens system over its whole aperture: as far as the lens is concerned, each object point sends a cone of light to the objective sufficient to fill the clear aperture.

These rays upon reaching the lens cannot all be treated the same, for even in the case of an axial point the focus depends upon the incident height of the ray. Here, with an object point off the axis, the situation is even more complicated, for the rays in an oblique plane will find an effective surface curvature different from that in the plane at right angles. The result of this difference in curvature is astigmatism.

Tangential, Sagittal Planes

One plane, the one we normally consider in making drawings and in designing, the one containing the object, we call the *primary* or *meridional* plane, the "focus" of which gives sharp images of points lying on a circle whose center is the axis, and fuzzy images of radial lines. This particular focus is called the *tangential focus*, and the meridional plane alternatively as the *tangential plane*.

The plane perpendicular to this we call

(*Continued on page 22*)

IN THE SPOTLIGHT

By *HARRY SHERMAN*

A FAR-REACHING decision affecting the status of radio and television broadcasting studio employes was handed down recently by the National Labor Relations Board. The Board found that without modifying the unit description (stage electricians, stage carpenters, and stage property men, excluding all other employes and supervisors at station WNBT, New York, of the National Broadcasting Company), engineers or any other NBC employes, *irrespective of their job designations*, who regularly spend more than 50% of their time handling and placing Tv lights in the manner set forth in the decision in this case, *are in effect stage electricians* and belong in the unit for which the IATSE has been certified as exclusive bargaining representative.

On July 13 last, IATSE, NABET (National Association of Broadcasting Engineers and Technicians), and NBC filed a joint petition requesting the Board to clarify the unit description by indicating whether or not in its decision the Board intended the classification "stage electricians" to be limited *only* to those employes *bearing that title* on the NBC payroll; or whether the Board also intended that NBC employes, regardless of their job titles, who regularly spend more than 50% of their time in the handling and placing of Tv lights should be included in the unit. In its decision, the Board states, in part:

"Having reconsidered the record on which the decision in this case was based, we are convinced that this work can be and is effectively being accomplished by the *traditional stage electrician* of the stage and amusement world. When an engineer ceases to perform such work *as a mere incident* to his all-around engineering functions, but regularly takes on these duties as his *main operation*, he thereby forsakes his special field and assumes the character of a stage electrician."

• We are happy to report that Bill Covert, 2nd IA vice-president and business representative for Toronto Local 173, has licked a six-weeks stretch in the hospital and is now recuperating at home.

• We were saddened to learn of the sudden death several weeks ago of Julius J. (Chief) Schaefer, 62, member of Dallas Local 249. Schaefer was found lying on the floor of the projection room of the Palace Theater, where he had worked for the past 30 years, and it was at first thought that he succumbed to a heart attack. However, upon his removal to the Parkland Hospital it was discovered that a skull fracture caused his death.

Schaefer was one of the original organizers of Local 249 and served as its president for more than a quarter of a century. In January, 1949, he was awarded a gold life membership card for his unswerving loyalty to the organization. He was a member of the American Federation of Labor for 44 years, of Dallas Masonic Lodge, Hella Temple, and of the American Legion. He was a veteran of World War I, having served overseas with our fighting forces.

He is survived by his widow and seven brothers—Henry, Rudolph, Ernest, Oscar, Conrad, Herman and Harry Schaefer, all of Cisco, Texas. Pallbearers at the funeral were Henry Long, Earl Holt, Clarence Holt, H. D. Hill, Charles A. Harcum, Paul W. Humphries, Fred Hanson, and Leon Saucier.

• We received a visit several weeks ago from Archie Stone, member since 1908 of Cleveland Local 160, and his son, Dr. Harry J. Stone. Father and son, and their respective families, were en route to Wrightsville Beach, N. C., where the doctor was elected national senior vice-commander of the National Army and Navy Legion of Valor. Dr. Stone, who now makes his home in Ashland, Ky., was awarded the Distinguished Service Cross in World War II for "extraordinary heroism in action near Anzio, Italy." (See IP for July, 1944, p. 18.)

• The 66th annual convention of the Ohio State Federation of Labor was held in Columbus, Ohio, last month, with the Columbus Central Body acting as host to the delegates. Bob Greer, old-line member of Columbus Local 386 and president of the Body, extended a hearty welcome to the gathering.

• Pinch-hitting for the labor editor of the New York World-Telegram and Sun, who was on vacation, IA President Walsh was the guest columnist for Wednesday, August 29. His subject, of course, was the effect of Tv on the members of the Alliance and their ability to cope with this revolutionary development in the entertainment world. He outlined briefly the early history of the IA, telling of its struggles to gain a foothold as an organizing unit and how it overcame many obstacles on the road to its present high estate in Labor circles.

"The cooperative merit of show-business unionism again was demonstrated in 1919," wrote Walsh, "when stage employes played a large part in gaining recognition for Actors Equity in New York —and later when both stage employes and moving picture machine operators helped gain recognition for the studio mechanics in Hollywood.

"By today our services have been extended to virtually all film-studio technicians, as well as to front-of-the-house personnel at the theaters and employes at the home offices and regional exchanges of the film companies. . . .

"Now, for a fourth time, the horizon of show business is being pushed back. As before, we have good reason to believe we can take it in our stride—and are confident that the theater will continue to prosper, drawing sustenance from television and, in turn, helping to sustain it.

"In organizing television, we of the

Studio Blacksmiths in IA

If there be any Labor organization with more diversity of occupation among its members than the IA, we have yet to hear of it. For now we have an IA brothers—take a deep breath—blacksmiths! The IA recently won an election contest with the Blacksmiths' International to add to the IA roster the 25 blacksmiths in Hollywood studios. The vote was 17 to 3.

IA seek to avoid labor strife . . . we always bargain with patient firmness, and the completeness of our organization has made strikes largely unnecessary. Thus the industry has been stabilized. Today the skills of IA members are behind every network telecast. Quite a number of our veterans have entered this field, and we have enrolled many of its previously-unorganized workers. To others who find employment in the big expansion which lies ahead, our ranks are open."

• The recent promotion of Mike Yahr, for many years Chicago representative for RCA, to that of manager of sound products sales of the RCA Engineering Products Dept., came as no surprise to his many friends in the craft. Mike is highly regarded in the industry and he has the best wishes of his many IA friends for success in his new post.

• The 3rd District (New England) held its annual convention last month at the Hotel Statler, Boston, Mass. IA President Walsh addressed the gathering, outlining approved IA procedure in organizing independent radio and television stations. He suggested that the Local Unions take the necessary preliminary steps to lay the groundwork, and that a representative from the General Office be called in to close the negotiations.

Other speakers included General Sec.-Treas. Raoul; Ass't IA Pres. Shea; Trustee Wm. Scanlan, and Benjamin J. Hull, Associate Commissioner of Labor for Mass. and member of Springfield Local 186. About 70 delegates, representing 60 Local Unions, were present at the meeting.

• We were sorry to hear that ill health forced the resignation of Matt Kennedy as business representative for Local 273, New Haven, Conn. Matt has represented the Local for the past 15 years and is very popular with his brother craftsmen.

• Many of the more progressive IA Locals Unions have working contracts covering 16-mm showings in their respective localities. The terms of these contracts vary somewhat, depending upon conditions prevailing in the different localities. George Schaffer, business representative for Los Angeles Local 150, recently sent us a copy of the Local's agreement with the Thorobred Photo Service of L. A., relative to the showing of 16-mm pictures at race tracks. Highlights of the agreement follow:

A. Projectionists employed full time shall receive $132.50 per week, basic weekly salary, 8 hours per day, 5 days per week. All time over 8 hours in any one day shall be paid at the rate of $4.97 per hour. All time worked over 5 days in any one week shall be paid at the rate of $4.97 per hour for an 8-hour day. An 8-hour day shall be worked within 8½ consecutive hours in any one day, with one-half hour lunch period.

B. Projectionists shall receive four percent (4%) of their total salary at the end of employment for vacation pay.

C. The PARTY OF THE FIRST PART (the employer) agrees that when desiring to dispose of the services of a projectionist furnished by the PARTY OF THE SECOND PART (IA Local Union), he will give the projectionist two weeks' notice, in writing, said notice to be considered as starting with the next payroll week; or two weeks' salary in lieu thereof, except in case of drunkenness, dishonesty, or incompetency, in which case notice will not be required. This notice may be waived by permission, in writing, from the PARTY OF THE SECOND PART.

D. PARTY OF THE SECOND PART agrees that all projectionists furnished by them who desire to leave the employment of the PARTY OF THE FIRST PART shall give the PARTY OF THE FIRST PART two weeks' notice, in writing, said notice to be considered as starting with the next payroll week. This notice may be waived by permission, in writing, of the PARTY OF THE SECOND PART.

E. The PARTY OF THE FIRST PART further agrees that in the event he dispenses with the services of any projectionist hired under this agreement, or said projectionist leaves the employment of the PARTY OF THE FIRST PART for any reason whatsoever, said PARTY OF THE FIRST PART will replace the employe leaving with another projectionist that is furnished by the PARTY OF THE SECOND PART.

F. Projectionists will not be requested or required to perform any act that is in violation of the terms of this agreement or the Constitution and By-Laws of the PARTY OF THE SECOND PART.

G. It is further mutually agreed that inasmuch as the PARTY OF THE SECOND PART is a member of the IATSE of the United States and Canada, nothing in this agreement shall ever be construed as interfering with any obligation the PARTY OF THE SECOND PART owes to such IATSE of the United States and Canada by reason of a prior obligation.

Schaffer advised us that copies of this agreement have been sent to all IA Locals in California, as a guide in future 16-mm negotiations.

Marty Bennett Heads Up RCA Theatre Sales

Martin F. Bennett, well-known RCA theatre sales representative in the Eastern Region, has been named Sales Manager of the Theatre Equipment Sales Section of RCA Engineering Products Department. Mr. Bennett succeeds J. F. O'Brien, recently promoted to the post of Sales Manager of RCA's Theatre, Visual and Sound Section.

Marty Bennett, new head of RCA theater equipment sales

A native of Brooklyn, N. Y., Mr. Bennett has been active in theatre circles for more than 20 years. Prior to joining RCA in 1946, he served for 14 years with Warner Bros. Theatres as supervisor of sound projection in the New York area. He is active in the Society of Motion Picture and Television Engineers and the Variety Club, and served as President of the Warners Club for several years. He is a graduate of New York University and also attended St. Francis College.

• We regret having missed the visit of W. E. J. Rose, member of Local 91, Boise, Idaho, when he called at the IP offices recently. Rose and his family had just returned to the States after an extensive tour through several European countries. Another out-of-town visitor we failed to connect with was Walter Roberts, member of Local 178, Salisbury, N. C., who called for the second time in as many months—both times while we were out-of-town.

Safety Film in Mass. Suit

Contending that safety base film is less hazardous than common newspaper and that the application of the regulation concerning nitrate film should not apply when safety film is used, three Massachusetts theatres have filed an amendment to their suit seeking clarification of existing laws concerning the regulation of projection practices.

Amendment to the petition states that the laws applying to nitrate films should no longer apply to cellulose acetate or equally incombustible safety film.

From American Cinematographer

"Hello! A. S. C.? Send me two more cameramen—LEAN ONES!"

N.T.S. Observes 25th Birthday

NATIONAL THEATRE SUPPLY CO. observed its 25th anniversary early this month (Sept. 3). Pioneer nationwide distributor of motion picture theatre supplies, the NTS record has been embellished by a complete theatre service which has featured construction, remodelling, and equipping theatres from roof to cellar, with the over-all operation being financed by the most liberal credit plans ever known in the theatre field.

Nor has the NTS operation been confined to the national scene: today its export department renders the same inclusive service to theatres and auditoriums in the far corners of the earth.

Technological Revolution in 1926

The natal year of N. T. S., 1926, saw the industry almost overwhelmed technologically by the sudden and furious onslaught of sound motion pictures. "Revolutionary" is the only truly descriptive word to describe the abrupt change in both equipment and technique in America's motion picture theatres. Speed in both installing equipment and in training personnel was of the essence.

OSCAR OLDKNOW
Vice-President

It was in this surcharged atmosphere that N. T. S. was launched, and it is one of the company's proudest boasts that events were taken in their stride and thousands of theatres equipped with a mass of new equipment without scarcely missing a show in the process.

N. T. S. headquarters were first established in Chicago, with Harry S. Dutton as president; while Walter E. Green and Oscar Oldknow were vice-presidents. In an incredibly short time 31 branch offices were opened in the major film centers throughout the United States. Today there are 29 National branches in operation, the reduction of two being effected as a result of improved communications and speedier distribution methods.

Personnel With 'Know-How'

President of National today, and for the past 23 years, is Walter E. Green. The headquarters were removed in 1930 to New York at 92 Gold Street, where they have been ever since. Oscar Oldknow is now vice-president on the West Coast, he and Mr. Green being the only officers of the company who are members of National's 25-year club.

Other personnel who have been with National for 25 years or more are: A. T. Crawmer, Minneapolis; Louise Ferguson, Denver; N. C. Haefele, Baltimore; J. H. Kelley, Cincinnati; Bertha Kreinik, Buffalo; G. C. Lewis, Philadelphia; G. J. Libera and B. A. Benson, Warehouse; F. J. Masek, Cleveland; J. J. Morgan, Denver; Marion Oviatt, Kansas City; O. A. Peterson, Minneapolis; M. B. Smith, Los Angeles; and N. F. Williams, Pittsburgh.

N. T. S. now has an operating personnel of about 300 people, including 125 sales and service representatives. It would seem that the imminence of widespread theatre Tv will occasion further moves to strengthen and expand this organization in this highly important respect. National is now serving more than 13,500 exhibitors throughout the United States, the theatres ranging in size from 200 seats all the way up to the gigantic Radio City Music Hall in New York.

A. F. BALDWIN
Export Manager

WALTER E. GREEN
President, National Theatre Supply Co.

Close Projectionist Ties

One of the cardinal principles of N. T. S. operation down through the years has been the extremely close ties it has established and maintained with projectionists, this policy being based on the belief that the man who uses the equipment is a vital factor in the uninterrupted smooth operation of the motion picture theatre. N. T. S. is always among the very first and the most liberal in support of all projectionist activities —a policy which has earned the company the gratitude and full cooperation of the craft. Particularly instrumental in the furtherance of this policy has been Arthur Meyer, who directs the projector —visual and sound— department of N. T. S. The name Meyer is practically synonymous with Simplex projectors.

ARTHUR MEYER
Vice-President in Charge of Projector Dept.

Bases of Operating Policy

The list of products sold and installed by N. T. S. would fill this page and more, but it never ceases growing in order to effectuate National's promise to supply every bit of equipment for every type of theatre from cellar to roof—in addition to servicing all open-air amusement centers.

Exhibitors and projectionists—in fact,

(*Continued Col.* 1, *next page*)

J. W. SERVIES
Carpets and Purchasing

W. J. TURNBULL
Sales Promotion

J. E. CURRIE
Drive-Ins Theatres

A. J. LINDSLEY
Advertising Manager

Exhibitor-Producer Groups Meet to Spur Theater Tv

REPRESENTATIVES of exhibitor organizations meeting formally for the first time with the MPAA's (producers) Tv committee (Sept. 10) rung up progress toward a unified industry approach to the FCC on the allocation of exclusive Tv channels for theaters. One concrete result of the meeting was the designation of an engineering committee comprising engineers of the exhibitor groups, the MPAA, and several of its member companies.

Appointed to serve on the group, which will meet from time to time in advance of the FCC hearings on the pending application for channel allocations, were: Frank McIntosh, Andrew Ingles, MPAA; C. M. Jansky and Stuart Bailey, TOA; Earl I. Sponable, 20th-Fox; Paul Raibourn, Paramount; Frank Cahill, Jr., Warners; David W. Atcheley, Jr., United Paramount Theaters.

Vital Questions Posed

Among other things, the engineering committee is charged with coordinating the thinking of the organizations represented on the numerous technical problems involved in the Tv frequencies allocation move and the development of a theater Tv network. In the discussion these questions loomed large:

1. Should the size of the channels for theater Tv be eight or 10 megacycles? Color Tv is a factor here.

2. Is it desirable to rely for program transmission upon a private carrier or, instead, upon a "co-operative" carrier?

3. If a "co-operative carrier" is to be established, what financing will be entailed, and how will it be provided?

The latter, it was estimated, eventually could entail the expenditure of millions. However, the present plans are to develop network theater Tv gradually. Thus, in the presentation to the FCC the hook-up proposed will span the distance from Washington to Boston, taking in of course the cities in between. Admittedly, the problems arising are made the more difficult of solution because there are no precedents to go by.

While the FCC hearings are now set for Nov. 26, it was said that a further delay was not impossible. Thus, the hearings might be held sometime early in the new year. No date was set for the next joint meeting, but it was said that further parleys to hammer out a joint approach, mutually agreeable, would be held.

NTS Spots 35 Simplex Tv Units in Theaters in West & South

Sales of 35 Simplex theater Tv equipment within the past two months are reported by National Theatre Supply Co., distributors of the theater Tv equipment —both direct-projection and videofilm— manufactured by its affiliate, General Precision Laboratory. The orders include 23 direct-view and 12 videofilm equipments.

This report by National followed a series of special Tv "clinics" held through the South and West at which exhibitor reaction was described as "most enthusiastic." National is at present the only company offering both types of Theater Tv units.

The first Simplex large-screen theater Tv equipment was installed in the Fulton Theatre, Pittsburgh, where it has been operating since last March.

Tv-Vaudeo Looms via Coaxial Unit in Capitol Theatre, N. Y.

Now it's Tv-vaudeo in the making. A. T. & T. has installed in the basement of Loew's Capitol Theatre on Broadway, N. Y., a coaxial cable junction. A. T. & T. sought and paid for the installation because of the Capitol's advantageous location as a central service point for theatre Tv to houses in the Times Square area.

Loew's executives see in the development the makings of a hookup which would enable them to stage a show at the Capitol and transmit it by direct wire to many chain outlets in innumerable cities.

Unlimited Program Possibilities

Possibilities of such a program are virtually unlimited. Under the setup, theatre audiences able to see top headliners would be the largest in history. At the same time, artists' salaries would zoom to unprecedented heights because of the huge audience in various cities. At the same time, commercially sponsored video would have to compete with theatre Tv for headliners, just as tele sponsors must vie with theatres in the showing of prize fights.

Problems to be met, once a theatre-vaudeo circuit is established, will be tremendous, as full development of this facet of the business will create a show business revolution. It's conceivable that a similar system can be used for transmission of legit plays, operas, etc.

The Capitol installation will also permit the house to receive direct wire transmissions from another theatre, studio or outside-inside location where a special event is staged, and thus can serve as a relay point to other theatres.

New Rates Set for Tv Cameramen

The Association of Documentary and Television Film Cameramen has announced new wage scales, effective Aug. 15, as follows: cameramen, $62.50 per day, $225 week; soundmen, $35 per day, $150 per week; assistant soundmen, $28 per day, $120 per week.

Role of Photography in Tv

Photography's role in television is reviewed in the current issue of "Highlights," Eastman Kodak publication for stockholders. The article states, in part: "At least 30% of all Tv programs now on the air are on film (recent trade press

N.T.S. OBSERVES 25TH BIRTHDAY

all elements of the equipment branch of the industry—are expected to join in extending recognition during this 25th anniversary year to a company which has launched and kept operating year after year many thousands of motion picture theatres, and which has done so on a basis of fine equipment, speedy and reliable service, and an over-all policy of fair and square dealing.

National Theatre Supply Branch Managers

R. J. MAURO—Albany
J. C. BROWN—Atlanta
A. C. HAEFELE—Baltimore
H. J. MCKINNEY—Boston
V. G. SANDFORD—Buffalo
R. D. TURNBULL—Charlotte
R. P. ROSSER—Chicago
J. H. KELLEY—Cincinnati
F. J. MASEK—Cleveland
R. L. BOSTWICK—Dallas
Memphis
J. B. STONE—Denver
A. C. SCHUYLER—Des Moines
C. B. WILLIAMSON—Detroit
B. N. PETERSON—Indianapolis
A. DE STEFANO—Kansas City
LLOYD C. OWNBEY—Los Angeles
A. J. LARSEN—Milwaukee
A. T. CRAWMER—Minneapolis
W. G. MILWAIN—New Haven
A. G. SMITH—New York
T. W. NEELY—New Orleans
J. I. WATKINS—Oklahoma City
G. K. SLIPPER—Omaha
W. J. HUTCHINS—Philadelphia
N. F. WILLIAMS—Pittsburgh
W. C. EARLE—St. Louis
H. H. RANDALL—San Francisco
O. L. CHINQUY—Seattle
Chicago Warehouse—
B. A. BENSON

estimates even put the figure at 50%). This percentage, moreover, is rising as the advantages and methods of using films become better known.

"For 1951 Tv will use an estimated 300 to 350 million feet of film. Most of this will be black-and-white, 16-mm motion picture film; the rest 35-mm." Discussing the usefulness of film in television, the article states: "Film enables producers to make some programs . . . that would be next to impossible to do 'live.' . . . Again, film can be slowly and carefully edited—'on the air' pressure is absent. There are no 'flubbed' lines. Special effects, like animated cartoons, can be created.

"Films can be used repeatedly. In this way the cost of a show can be spread out over more air time and more sponsors. Larger audiences can be reached—a film show can be projected at the best time for advertising regardless of time zones. Interestingly, a number of producers are already shooting Tv films in color. These are printed on black-and-white film for screening now. But, when needed, they'll be ready for use again on color telecasts."

Tv Greater Threat to Mags

News and picture magazines which are prematurely burying the motion picture industry as a victim of television are more likely to supply the corpse, Allied's general counsel, A. F. Myers, warned. Myers had reference to a recent story in *Life* magazine, based upon a survey in which interviewers were shown agreed that Tv will kill off the movies.

"Weekly news magazines, like *Life* and its stablemate *Time*, have a lot more to fear from Tv than the movies," said Myers, reminding that "Tv's great contribution is the instantaneous transmission of important and interesting events by sight and sound. As an art medium, even as an entertainment medium, Tv has limitations which cannot be overcome. It can never be more than a parlor peep show or animated billboard. But as a medium for the instantaneous depiction of great events, it has no rival."

Marconi's Famous 'Why?'

Hitherto unpublished correspondence of Guglielmo Marconi has been incorporated in a new booklet written by Orrin E. Dunlap, Jr., vice president of RCA. Unfolded here is story of Marconi's yearning to learn the mysterious cause of the great invention he fathered.

"Indeed, the 'why' of radio continually challenged Marconi," Mr. Dunlap writes. "After a night of vigil in long-distance test of wireless between the English Channel and Australia, he turned to a friend on board the Elettra (Marconi's yacht) and with a perplexed expression remarked:

" 'There is one thing I would like to know before I die—why this thing works!' "

To the Editor of IP:

I have read the articles on "The Magic of Color," by Robert A. Mitchell, with great interest. There is one point in Mr. Mitchell's treatment of the subject which I should like to correct—namely, where he refers to me as "inventor" of Technicolor. Actually, the Technicolor process was not invented by any one man but by a group of men; and no doubt Mr. Mitchell intended to convey that I was one of the group of which I have functioned as Director and General Manager from the outset.

HERBERT T. KALMUS

President, Technicolor
Motion Picture Corp.

To the Editor of IP:

I read with great interest the article on film damage in IP for July ("Seven-Year Survey of Film Print Damage," p. 12) and I am wondering whether similar surveys have been made covering 35-mm film.

Film exchanges keep booking records, but they do not seem to tabulate the number of runs during a single booking, a figure that would be needed in any accurate evaluation of film life. From time to time replacement footage is inserted in features of recent release, particularly the so-called big pictures, but the data on such replacements, other than that required to order the footage from the laboratory, is sketchy.

I believe that it would be interesting to have such information on 35-mm film recorded and published.

L. F. ADAMS

Beverly Hills, California

[Inquiries by IP reveal that no such data in the form outlined by Mr. Adams is available. Such a project would certainly be very much worth-while, particularly in view of the present critical shortage of film stock. IP is exploring the topic further and hopes to be able to present such data in the near future.—ED.]

To the Editor of IP:

I am extremely interested in your excellent magazine which is contributing highly thought-provoking articles in the field of motion picture and sound projection. Unfortunately, we here do not enjoy the many facilities available to your people—magazines, books, laboratories, *etc.* I have received your magazine for the past three years, but we have missed many fine articles in past issues which are now unavailable.

I am particularly interested in data on drive transmission and on sound picture equipment circuits. Shortly I shall send to you the prospectus of our course.

M. RAM MURTHY

Instructor, Sound Dept.,
S. I. Occupational Institute,
Bangalore, South India

To the Editor of IP:

Will you please kindly teach us the competent authorities for motion picture theater projectionists as followed in the United States? In Japan, the Ministry of Labour and the fire-brigade are both the competent authorities in such matters.

Also, we should like it very much if you could send us samples of the questions asked in the United States.

TOSHIO MIYAMOTO

Manager, Shinkoiwa Theatre,
Tokyo, Japan

[Every possible assistance will be rendered to these advocates of better projection in foreign lands. It would seem that the examination of projectionists in Japan does not differ in the main from the pattern established in the U. S. A. Here are two standout examples of people who are thirsty for information, so readily available, that we in America so blithely gloss over or, worse, ignore.—ED.]

To the Editor of IP:

Having resurfaced hundreds of motion picture screens, I have become convinced that the weakest link in the projection chain is the screen itself. Deterioration takes place slowly, insidiously, and is often not noticeable to the exhibitor and the projectionist who view the surface daily.

Checking screen efficiency is a simple matter: go on stage and switch on the footlights or the border lights; if such lights are not available, use a 150-watt flood- or spotlight. Take a freshly laundered handkerchief and hold it against the screen. The contrast is amazing!

A new screen is, of course, the best solution. But lacking this, resurfacing, which is 90% effective, is the answer. A simple process, resurfacing can be done by anybody—provided a special paint properly compounded is used. A diffusive-type paint and a highly reflective surface are "musts." Our product, Arctic Blanch, can be applied successfully by anyone familiar with the operation of a spray-gun. Use 40 pounds pressure, which is enough to go through the sound perforations without occasioning clogging.

A large majority of screens are in a

deplorable condition: they cause eyestrain which induces a headache—for the patron and for the box-office. This situation is right down the projectionist's alley, and he should be on his toes to check and advise management as to the condition of the screen.

KEN CLADWELL

National Screen Refinishing.
Buffalo, N. Y.

To the Editor of IP:

I should appreciate it if you would give me a simple explanation of the term "peak inverse voltage," particularly as applied to rectifers.

HERBERT R. SALTER

Los Angeles, Calif.

[In rectifier terminology, inverse voltage is that voltage which is applied across the rectifier (and which the rectifier must be able to withstand) when the applied A.C. voltage is passing through its negative half-cycle and the rectifier is not conducting. Peak inverse voltage is the maximum value of voltage which is applied to the rectifier unit under these circumstances.

If the peak inverse voltage is too high, the rectifier may be damaged by breakdown. For this reason, the peak inverse voltage rating is an important rectifier characteristic which must not be neglected by designers and users of power supply equipment.

The magnitude of the peak inverse voltage depends upon the nature of the rectifier load circuit, as well as upon the type of rectifier circuit and the applied A.C. and output D.C. voltages.—ED.]

Carbon Drippings Collection

The copper dripping salvage program, initiated last month, is well under way, according to Nathan D. Golden, of the NPA. Communications from the various trade and union associations participating in the program indicate a high degree of cooperation on the part of all segments of the industry.

Marc J. Wolf, Chief Barker of Variety Clubs International, has charged the Chairman of the Welfare Committee of each Tent with the responsibility of supervising the operations of the program in each film distributing territory. In the point-by-point instructions, it was emphasized that the basic responsibility for the collection of such copper drippings from theaters was in the hands of a designated group of theater equipment dealers in each film distributing city. The instructions also provided that all theater equipment dealers in every city would cooperate in the program.

Procedure for Disposal

In general, it was provided that *any* theater equipment dealer in the country who received copper drippings from theaters would either transfer such drippings to the *designated* theater equipment dealer in his city, or would arrange with the local Variety Club Welfare Committee to sell the drippings which he collects to a suitable metal scrap dealer. The proceeds from such sales go to the Welfare Fund of the local Variety Club.

This entire copper dripping program is an industry-wide effort and every segment in the industry is being asked to cooperate to the greatest extent possible.

Delay in Filing CMP Forms; Oct. 1 Absolute Deadline

Although the Controlled Materials Plan providing for the allotment of specific quantities of iron, steel, copper and aluminum was introduced by the NPA July 1, 1951, it will become fully effective during the fourth quarter of this year. Commencing October 1, 1951, manufacturers will find it virtually impossible to obtain suitable quantities of controlled materials without CMP allotments. At the same time, they will require a priority rating for the procurement of non-controlled materials and components.

Some Manufacturers Lax

All manufacturers were instructed to file fourth quarter CMP-4B applications for controlled materials with their Industry Division of NPA during the month of July. A considerable number of manufacturers who filed third quarter applications have so far failed to file their fourth quarter applications, as instructed. NPA applications for controlled materials for the first quarter of 1952 must be filed befor October 1, 1951.

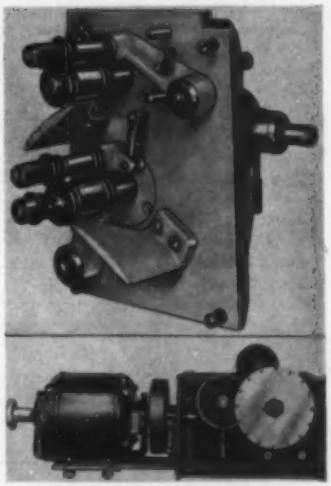
Manufacturers are reminded of the fact that they should file only one CMP-4B application under each product code for their requirements. However, where the production of repair and replacement parts are separately scheduled, the requirements for such parts must be incorporated into a separate CMP-4B application.

Model 9 Ballantyne Soundhead

Simplicity in design and operation, plus an extremely low flutter level, marks the new Ballantyne Model 9 soundhead which has just been put into operation in theaters. Flutter in the Model 9 is more than 50% less than the accepted Academy minimum: the Academy standard is 0.15%, while the Model 8 has a rating of from 0.02 to 0.08%.

The complete gear box and film drive assembly of the Model 9 is removable as a unit from the front side of the head, making for extremely simple servicing. The gear box itself is of the worm gear type, designed for at least ten times actual operating load. The constant speed sprocket is driven by a large bronze worm gear and loaded to provide smooth

NEW BALLANTYNE SOUNDHEAD



Top: entire upper and lower sprocket assembly in gear box removed as a unit from operating side. Pad roller assembly is held in place by a new compression-type coil spring lock.

Bottom: simplified gear drive and perfectly balanced, ball bearing-mounted, oil-damped filter, with flywheel and case machined from solid steel bar stocks. Note motor handwheel for easy threading and adjustable motor mount. Two simple gears drive entire projector. Gears and pinions are key-mounted on shafts, and entire gear box is factory-sealed.

operation. All shafts are ball bearing-supported and have individual oil seals. The sprocket assembly has positive action compression-type coil-spring locks with adjustable stops for positioning pad rollers.

The scanning drum and shaft rotate on lifetime sealed ball bearings and are ground as one unit to a tolerance of plus or minus .0002. The filter flywheel is perfectly balanced, ball bearing-mounted, oil-damped, with the flywheel and the flywheel case machined from solid steel bar stock for perfect balance. The case is impervious to oil.

West Coast RCA 16-mm Distributor

Coast Visual Education Co. has been named distributor for RCA 16-mm sound-film projection equipment serving the metropolitan Los Angeles area. Formed in 1944, CVE (A. Paul Cox, Robert C. Thomas, and Bill Utz) will sell and service all RCA audio-visual products, the service department personnel having been factory-trained by RCA.

CVE has modern salesrooms and service and warehousing facilities, including 4500 square feet of floor space, at 5620 Hollywood Blvd., Los Angeles.

PHOTOGRAPHIC OPTICS

(*Continued from page* 15)

the *sagittal plane*. It is the plane which, in the normal optical drawing, lies perpendicular to the paper and cannot be drawn except in perspective. This plane gives sharp images of points lying along lines intersecting the optical axis, and because the effective curvature in the sagittal section is different from that in the meridional section, this focus is at a different position along the axis, *i.e.*, the sagittal focal plane is displaced from the tangential.

Thus in the presence of astigmatism an extra axial point gives rise to two approximations to an image: (1) a constriction in the bundle of rays which takes the form of a short line in the plane of the axis and the object point, and (2) a short line perpendicular to and separated from the former. These are the sagittal (or radial) and tangential image lines, respectively.

Occupy Different Planes

These images will occupy different planes, the distance between them constituting the astigmatic difference, this being one important aspect of astigmatism. The other aspect of this aberration is the length of the astigmatic lines, which we shall consider briefly later.

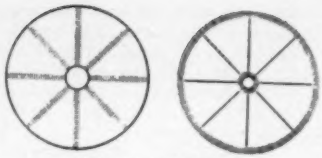


FIG. 11. Astigmatism.

Conventional Astigmatism Example

This aberration is usually explained in terms of the image of a spoked wheel with hub on the lens axis (Fig. 11). The spokes constitute radial or sagittal objects and are sharply imaged in the sagittal image plane, where the rim, a tangential object, is out of focus. The rim would be imaged sharply in the tangential image plane, where the spokes are out of focus. To find an approximately satisfactory focus for both simultaneously, it would be necessary to put the focusing screen or the emulsion midway between them at the position where the two focal lines degenerate into a disc, the circle of least confusion.

This disc represents the best compromise focus, and is easily seen to have a size determined by the length of these lines. The longer the lines, the larger is the circle of least confusion, and the less sharp the image.

Astigmatism is often noticed in photographs as a peculiar streakedness, usually tangential, in a background comprised of an assembly of small areas, such as leaves and their interstitial spaces. In this case the tangential focus at that point in the field is closer to the emulsion than the sagittal, and the background points are imaged as the appropriate astigmatic lines.

Points on the Axis

It will be noticed that here we have been considering the astigmatism of points in the field, *i.e.*, points off the axis of the lens. For points on the axis there is no astigmatism of the kind here considered, for there no difference of effective surface curvatures can exist in a symmetric system.

However, if some of the lenses are decentered, or more particularly, if there is an asymmetric component to the surface curvature as would be provided by a cylindrical surface, then, even on the axis, two mutually perpendicular separated focal lines would exist, and axial astigmatism would occur.

This state does not usually exist in photographic lenses except for very special purposes. This is the type of lens provided to correct the astigmatism of the eye.

The lens designer finds that he can

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control astigmatism most effectively by means of varying the distribution of power among the components and uses this means to correct for astigmatism in

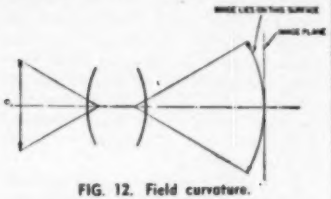

FIG. 12. Field curvature.

connection with the closely related Petzval curvature to be considered in the next section.

In practice, it is found that the astigmatic difference of focus is independent of the aperture, that is, that the stop has no influence on the positions of the tangential and sagittal foci. However, the lengths of the lines do vary directly with the stop. Thus stopping the lens has the advantage of shortening the lines, making the circle of least confusion smaller, and making the image more crisp.

Both the focal difference and length of lines vary sharply with image height, and, as in coma, become more serious near the margins of the field.

Petzval Curvature of a Lens

Even in a lens whose astigmatism is brought to zero, the image will be found not to line on a plane perpendicular to the axis, but on a spherical surface (Fig. 12). Here the image is sharp.

It is unfortunate that the film surface cannot be made to conform to a sphere, for the lensmaker's problems would be simplified. As it is, in the presence of field curvature, and with a flat filmplane, a compromise setting must be used (Fig. 13). The maker is to be congratulated on the high quality he achieves under such handicaps.

Petzval curvature is inherent in any lens, and can be looked on partly as a natural consequence of the fact that objects on the axis of a lens are closer to it than objects in the field, and thus will be imaged farther from the nodal points than objects occurring a distance from the axis.

Looked at in another way, to achieve a flat image of naturally occurring ob-

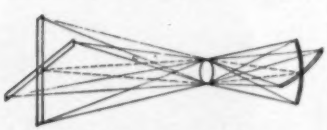

FIG. 13. Field curvature.

jects it is necessary that the lens or objective have different effective "focal lengths" in the margins and corners of the field than at the center, for other-

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wise the sharp image would be formed on the surface of a sphere whose radius is the equivalent focal length.

The degree with which the effective focal lengths become longer as the margins of the field are approached is the measure of the success of the lens designer in removing or ameliorating this particular stubborn aberration. The field curvature is a function of the type of glass used in the objective components, and further is influenced by the particular distributions of power among those components. By suitably choosing and/or altering these variables, the designer can reduce the Petzval curvature to a tolerable amount.

[TO BE CONTINUED]

ESTABLISHING THE BRIGHTNESS OF MOVIE SCREENS

(*Continued from page* 10)

screen brightness from center to edge should be established?

Little Recent Progress

None at the discussion reported herein could recall that any work specifically pertinent to the determination of a standard of screen brightness or to the conditions of theater viewing had been accomplished in the interval since 1936. O'Brien reported that the visual work since that time has been so fundamental in nature or directed to such different ends that its interpretation for the setting of theater viewing conditions might be extremely difficult.

The conference thought that the list of questions proposed by the Committee in 1936 was as adequate now as it had been at that time, that little progress has been made toward a direct answer to any of the questions, and that any such answer would result only from studies purposely designed to investigate the desirable brightness of projected pictures.

It was the consensus that a great deal of work could be done toward determining optimum conditions of theater viewing and that it would be worth while for the Screen Brightness Committee to sponsor such a research program. It was also felt that it should not be too difficult to outline experiments and to formulate a program which would take sufficient account of the difficulties involved to make a real contribution, and to be free of many of the criticisms leveled at early work on screen brightness.

Conditions of Experimentation

The conference agreed that any work pertinent to the determination of optimum theater viewing conditions must simulate very closely the actual theater viewing. O'Brien and Evans warned particularly against inferring from the measurement of fundamental visual functions the result under theater viewing conditions. The knowledge of vision and the contribution of the visual functions to the total task of viewing are insufficiently understood.

In suggesting and sponsoring research on theater viewing the Committee will be asked to indicate what scope of variables should be included. In the conference discussion, it seemed obvious that the viewing conditions must include the full range of present indoor and outdoor theaters when projecting motion pictures. It is probable that it should include also the range of projected theater television.

Committee-Sponsored Research

Furthermore, research sponsored by the Committee should aim to determine optimum viewing conditions regardless of their practicability. The research moreover should determine what compromises with this optimum can be made with the least sacrifice of picture qual-

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ity. The program should thus serve to indicate the goal toward which development of motion picture projection should proceed and should also indicate what temporary compromises with that objective can be made most justifiably.

Evans noted the corollary position of the various Tv committees which have been searching for data in this same field. If their research covered all Tv viewing, while the Screen Brightness Committee considered motion picture viewing, the data for the two fields would be complementary. For example, theater viewing probably covers the range of viewing distances from 1½ to 6 screen widths; while Tv viewing begins at 6-7 screen widths and continues to greater distances.

Significant Viewing Variables

Most important to the outlining of a proper research program, the discussion felt, was a tabulation of significant variables in theater viewing so that proper account could be taken in setting up experiments. The conference enumerated the following variables as definitely significant: (1) screen brightness; (2) surround brightness; (3) conditioning level of illumination; (4) viewing angle; (5) viewing distance; and (6) subject matter of test pictures.

A primary contribution of the meeting was a discussion of these variables; the discussion has been taken out of its temporal sequence and here organized by subject.

1. SCREEN BRIGHTNESS

Sensitivity of the observer to brightness changes was discussed, with Lozier and Chambers feeling that equal percentage changes in illumination are more visible at the lower brightness levels; for example at 2 ft-L a 100% increase in brightness appears more effective than a 100% increase at a level of 15 ft-L. Newhall suggested that the magnitude of such perception of brightness change is influenced greatly by the conditioning level of illumination preceding the test.

Color of the illuminant used during the test is important; Chambers reported that *the optimum level chosen under incandescent illumination has been found to be different from that chosen under arc illumination*, and that in particular the apparent contrast of a picture appears higher with arc quality illumination. Evans agreed that the apparent

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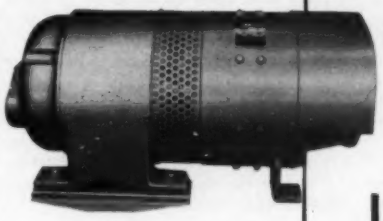

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contrast of the image varies considerably with the color of the illuminant.

Flicker inherent in the intermittent projection of motion pictures was discussed from two viewpoints: (1) the proper integration of an intermittently illuminated image, and (2) the perception of flicker as a distracting influence. The discussers felt that the indications of meters and measuring devices used to correlate work on screen brightness must be such as to have a response to intermittent illumination consistent with the response of the human eye.

With reference to the level at which flicker becomes distracting, Lozier reported observations indicating that flicker is objectionable above 15-20 ft-L. O'Brien, on the other hand, found no objectionable flicker in his experiment at levels up to 30 ft-L. Evans noted that while the threshold for foveal flicker is not exceeded by 48-cycle illumination at 30 ft-L, on the other hand the threshold for peripheral flicker at that intensity is well above 48 cycles.

Peripheral flicker begins to be observed at 48 cycles in the range of 15 ft-L. Thus, the sensitivity to flicker and the effect of flicker as a disturbing influence will be a function of viewing angle, decreasing as the viewing angle is decreased and as the vision becomes more nearly limited to the foveal region.

2. SURROUND BRIGHTNESS

O'Brien reported that in his opinion if his earlier research had made any single contribution it was to indicate that some definite surround brightness is desirable in the viewing of motion pictures, and that under normal theater conditions a surround brightness of approximately 0.05 ft-L is preferred by observers free to choose.

Spragg reported that wartime research on radar-screen viewing showed significantly better performance of the observer with a definite surround brightness. There was less fatigue, better perception of detail, and quicker response to the image, as the surround brightness was progressively increased up to levels nearly equal to the screen brightness itself.

Evans pointed out that—entirely apart from the fatigue, ease, and pleasure of viewing—the surround-brightness level changes the appearance of the picture as the surround brightness is increased from zero up to the highlight brightness, the illusion changes from that of viewing a projected picture to that of viewing a print.

Consequently, one factor influencing surround brightness is the determination of which viewing effect is desired and what criterion of desirability is chosen. Some of the newest theaters, Evans noted, are being so built as to use

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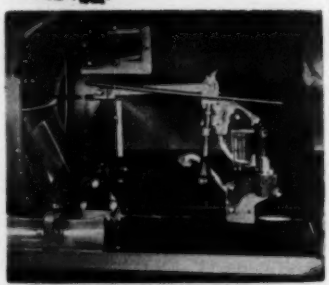

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a graded surround illumination. Newhall pointed out that the "surround effect" depends very much upon the visual angle subtended by the screen, and also upon the portion of the total visible angle that is covered by the "surround" under consideration.

3. CONDITIONING LIGHT LEVEL

Newhall pointed out several times during the discussion that the results obtained in a study of vision such as is anticipated in this discussion, depend greatly upon the conditioning level of illumination. He stressed the importance of conducting the test with the observers conditioned in the manner of a practical theatre audience.

4. VIEWING ANGLE

O'Brien in summarizing his previous experiments felt the outstanding defect was too restricted a viewing angle and pointed out that this defect was common to most of the early work on theater viewing. Spragg and Newhall, in discussing the interrelationship between surround brightness and viewing angle, pointed out the possibility that the optimum brightness may be a function of the viewing angle and that it should be so specified. Such a relationship might provide a basis for correlating indoor and outdoor theater recommendations.

Evans pointed out that committees of the Tv industry have been formulating questions similar to those proposed by the Committee, and that the scientific information desired by each group has much in common. For example, Tv viewing is very similar to motion picture screen viewing excepting that motion picture screen viewing angles are from 1½ to perhaps 6 screen widths, while Tv viewing begins at 6 screen diameters and continues to smaller angles.

O'Brien suggested a cooperative research effort to determine the functions of Tv and motion picture viewing, spanning this angular range.

5. VIEWING DISTANCE

Evans suggested that the influence of viewing distance cannot be neglected even when viewing angles are duplicated, and he recommended that at least some of the experimental work be done under the actual viewing distances—in addition to small screen studies that duplicate viewing angles only. One effect of viewing distance, for example, may be to influence the comfort of the visual task.

6. SUBJECT MATTER OF PICTURES

Evans pointed out that it may be much more important to have a large number of test scenes rather than to have a large number of viewers. He pointed out, for example, that the British choice of 7 ft-L for Technicolor and 12 ft-L for black-and-white viewing can easily result from a difference in the subject matter of the two film sections, rather than any fundamental difference in viewing. Evans and O'Brien proposed that by all means both color and black-and-white films be used.

There was at first a proposal that the viewing should duplicate actual conditions, employing a sound track along with the picture since that is the normal projection procedure. Evans and Weaver objected, however, pointing out that if sound affects vision, it will not be nearly so easy to judge how pleasing the picture is if there is a simultaneous, possibly distracting, sound track.

Judging Image Quality

If other than the viewing task itself is examined, O'Brien pointed out there will be no way of judging picture quality except by apparent fatigue, headache,

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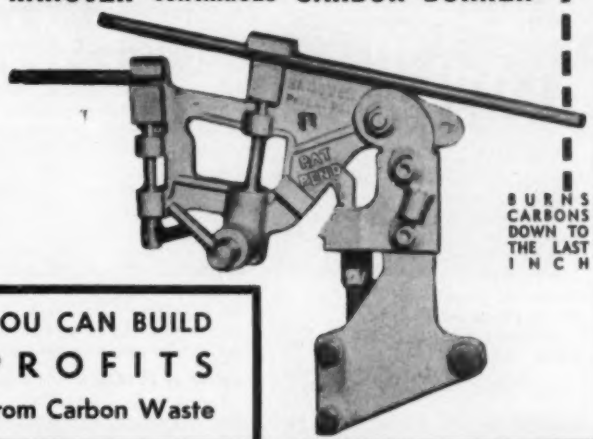

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etc. (Actually there seems to be no such thing as strictly visual fatigue. O'Brien pointed out, since the factors formerly attributed to "visual fatigue" are being explained by other factors entirely.)

O'Brien reported that the pictures for his experiment were chosen purposely to have neither interest nor boredom, because it was necessary to project them a number of times in testing a single observer. The results in such a test, he pointed out, may be different from those that would be secured with an interesting picture viewed for the first time only. Newhall emphasized that pertinent research must be based upon typical films.

In the discussion of color versus black-and-white, Spragg asked whether the permissible brightness range might be more easily limited for color pictures. Evans pointed out that color prints cannot be projected with as high screen brightnesses as black-and-white prints without a shift in color balance. Most color processes tend to depart from balance in the deep shadows, and the brightnesses must be kept low enough so that this departure is not obvious. The lower screen-brightness limits for acceptable image quality of both black-and-white and color appear to be equal.

Print Density Factor

The print density should correlate with release prints: Chambers pointed out that Tuttle's early work on print density is no longer applicable because of the general change to fine-grain emulsions for black-and-white, and that therefore the measurements of current print densities should be repeated. The question was raised and left unanswered—whether the ultimate result of increased available screen brightness might not be a mere increase in print density.

Chambers pointed out the commercial necessity for screen brightness uniformity such that the review-room brightnesses match the theater brightnesses, in order for the exhibitors to realize the kind of picture that is created by the directors and producers. Failure to keep this balance is responsible for the poor reception of some otherwise good pictures.

Nature of the Observer's Report

Spragg suggested that since the purpose of these experiments is to provide better theater viewing, the most important criterion is to meet the observer's preference. This type of judging was the basis of O'Brien's early experiments. Spragg suggested getting data from large scale experiments such as a whole auditorium full of observers.

It is desirable, the group agreed, to get observers who are not self-conscious of their task. This is difficult to realize, however, and the use of repeated matter with fewer observers is an experimental risk that sometimes cannot be avoided.

Spragg suggested that in his experience it has been preferable to have untrained observers judge which of several conditions they prefer rather than to have them manipulate conditions to reach an optimum. Typical of this procedure, Spragg pointed out, is the CBS practice of equipping its studio audiences with "yes" or "no" pushbuttons which are summed electrically. The audience is asked to indicate its reaction to the show as it progresses, and the electrical summation gives a continuous record of show interest.

Sampling Audience Reaction

Weaver suggested audience sampling, giving cards to the patrons of actual theaters, on which they might indicate they liked the performance and whether they would prefer to have had a brighter

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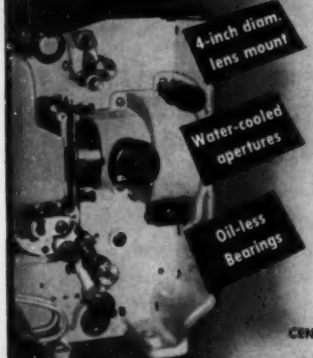

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or dimmer picture. Such sampling can be done at successive shows at varying screen brightnesses.

Chambers suggested that audience background-noise level might be lower and applause- and laughter-level higher at the best projection brightness levels, therefore, a better method of audience sampling might be to record the audience-noise level—"applause meter reading"—in a theater where the screen brightness can be varied from one day to another. This recording meter program, he pointed out, is extensively used in Hollywood to judge previews, and there has been found a presumable relationship between audience enjoyment and audience-noise level.

Spragg observed that the audience reaction to the pictures as judged by such meters is consistent, and if an audience laughs for a given time at a particular part of the picture each audience will repeat with amazing reproducibility.

Audience-Preference Meters

Chambers pointed out that 20th Century-Fox has used such meters in their West Coast preview theaters and that equipment-wise they are prepared to provide a range of screen brightnesses up to and beyond the usual levels. He suggested that 20th Century-Fox be invited to run such tests in theaters now fitted with these applause meters, where on successive days of projecting the same program, the screen brightness would be varied and the day-to-day audience reaction compared.

Such a comparison, he said, might give some very real and important data for answering the question of whether screen brightness is really important in judging the quality of a projected picture.

Proposed Accomplishments

In the discussion it was pointed out that the present standard, while intended to be temporary, has functioned as a permanent standard for 15 years. During this time changes in equipment, films, theaters, *etc.*, have been directed by the existence of this standard toward the maintenance of a constant screen brightness with variations in picture size, etc. It would be desirable, therefore, for fundamental research to indicate more clearly what optimum screen brightnesses should be, so that future technical improvements could be directed toward this optimum.

Even though present limitations might make it impossible for the optimum brightness to be realized, and even though a working standard might have to compromise with this optimum, the existence of suitable basic data should make possible the best possible compromise. Accordingly, the best attainable projection conditions would become the working standard, with future technical advances directed closer and closer to the optimum.

Conference Consensus on Topic

Consensus of opinion of this discussion was that a great deal of basic data on the factors influencing the viewing of projected pictures still remains to be determined. The conference agreed that it should be entirely practical for the Screen Brightness Committee to outline desirable research goals in such a manner that intelligent work directed toward their end would provide a real contribution to the science of viewing.

The conference felt that if the problems could be stated properly and succintly, and if suitable guidance could be available, there might be a number of groups willing to undertake the work as: (1) university research by students and staff members interested in the general field; or (2) industrial research sponsored by the companies interested in motion picture projection.

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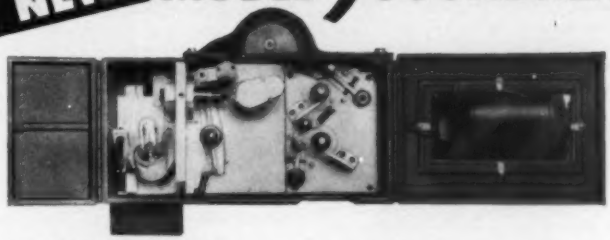

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THE MAGIC OF COLOR

(*Continued from page 6*)

genta light; tragedies and genre films with blue; slapstick comedies with yellow; mysteries and "horror" pictures with green or purple; adventures with red; westerns with amber, *etc.* But the titles of natural-color films should not be color-flooded because the titles are already colored.

When colored light is thrown upon a colored picture, the color-changes produced obey the *additive* laws of color formation discussed in the first part of this series. If the dominant hue of a Technicolor title background is red, blue light will change it to purple, and green to yellow. The lettering, if it be of another color, will undergo changes of hue which may cause it to "clash" in an unpleasing way with the background.

Auditorium lighting — especially illuminated clocks, exit signs, and sidelights in the vicinity of the stage—merits careful consideration. Of all colors, red is the most distracting; green the least. Sidelights near the front of the auditorium should be dispensed with entirely, if possible. Clocks and exit signs should be lighted with green, not red, bulbs. Aisle lights should be left white, the recommended blue not having sufficient visibility to assist patrons in locating their seats.

Technicolor Changeover Cues

It will be noticed that the changeover cue used on Technicolor prints is a serrated black disk outlined in green. The green circle is readily visible to the projectionist, who, of course, is watching for its appearance; but it is less noticeable to the audience than a white or red circle would be. This is another practical application of the fact that green is the least obtrusive of the colors.

The green outline is produced by inking the edges of the holes punched in the emeraude-exposed negative. This leaves a *white* ring surrounding the cue mark in the magenta-inked matrix. Through this white circle appear the yellow and cyan overprints in the positive. The yellow and cyan superimposed give emeraude, a slightly yellowish green.

Constant Focus Check

And this brings up the matter of changeovers when color films are being shown. The arc of the incoming projector should be struck at least 3 minutes in advance of the changeover in order that the discolorations inevitably produced by a "cold" carbon trim be avoided. The arc should be given a chance to "settle down" to normal burning before the changeover is made.

Focus must be checked at the start of each new reel of color film, and once again when the reel is about halfway through. "Film curl" causes focus drift; and nearly every roll of film has enough curl to throw the focus out slightly as projection progresses. Focus drift is likely to be really troublesome at times when lenses of short focal length (4½ inches E.F. or less) are employed.

A change from black-and-white to color *in the same reel* requires *immediate* refocusing of the picture.

The painstaking projectionist and the astute exhibitor are correct when they adopt a very critical attitude toward projection quality. Both know well that their livelihood depends upon patron satisfaction.

When projection faults are discovered, they should be diagnosed and corrected without delay. Projector parts, new lamps, and new lenses are much less expensive than loss of patronage. Many a theater business has been saved by replacing obsolete and cheaply built equipment which does not meet minimum standards of performance.

Old-Style Equipment Tabu

Bad projection is on a par with poor pictures, uncomfortable seats, and an uncongenial atmosphere in the theater. One or more of these factors, if present, can ruin any theater. There is no projector mechanism, lamp, or sound-system in existence which cannot be improved by the application of advanced concepts of equipment design; but the equipment now being offered is so far ahead of the archaic and worn-out "junk" with which thousands of projection rooms are cluttered that comparison is superfluous.

Color photography and sound recording have both forged ahead with giant strides in recent years. Old-time projectors and sound systems simply cannot do justice to modern films. *Now* is the time for the wise exhibitor to catch up with patrons' demands for high-grade screen entertainment. *Now* is the time for every theater-owner to make secure his investment against competing forms of entertainment. *Now* is the time because nobody—*but nobody*—can predict with assurance what may happen in these parlous times.

(The End)

SMPTE Hollywood Convention

Plans have been completed for the forthcoming 70th Semiannual Convention of the Society of Motion Picture and Television Engineers, to be held at the Hollywood-Roosevelt Hotel, Hollywood, California, October 15-19. Highlights of the Convention will be sessions on High-Speed Photography, Television, Magnetic Recording and Color Television. Taking time out from the week-long technical sessions and committee meetings, the Society, at its Semiannual Banquet on Wednesday, October 17, will present special awards for the most recent outstanding technical contributions to both motion pictures and television, including the newly established David Sarnoff Gold Medal Award.

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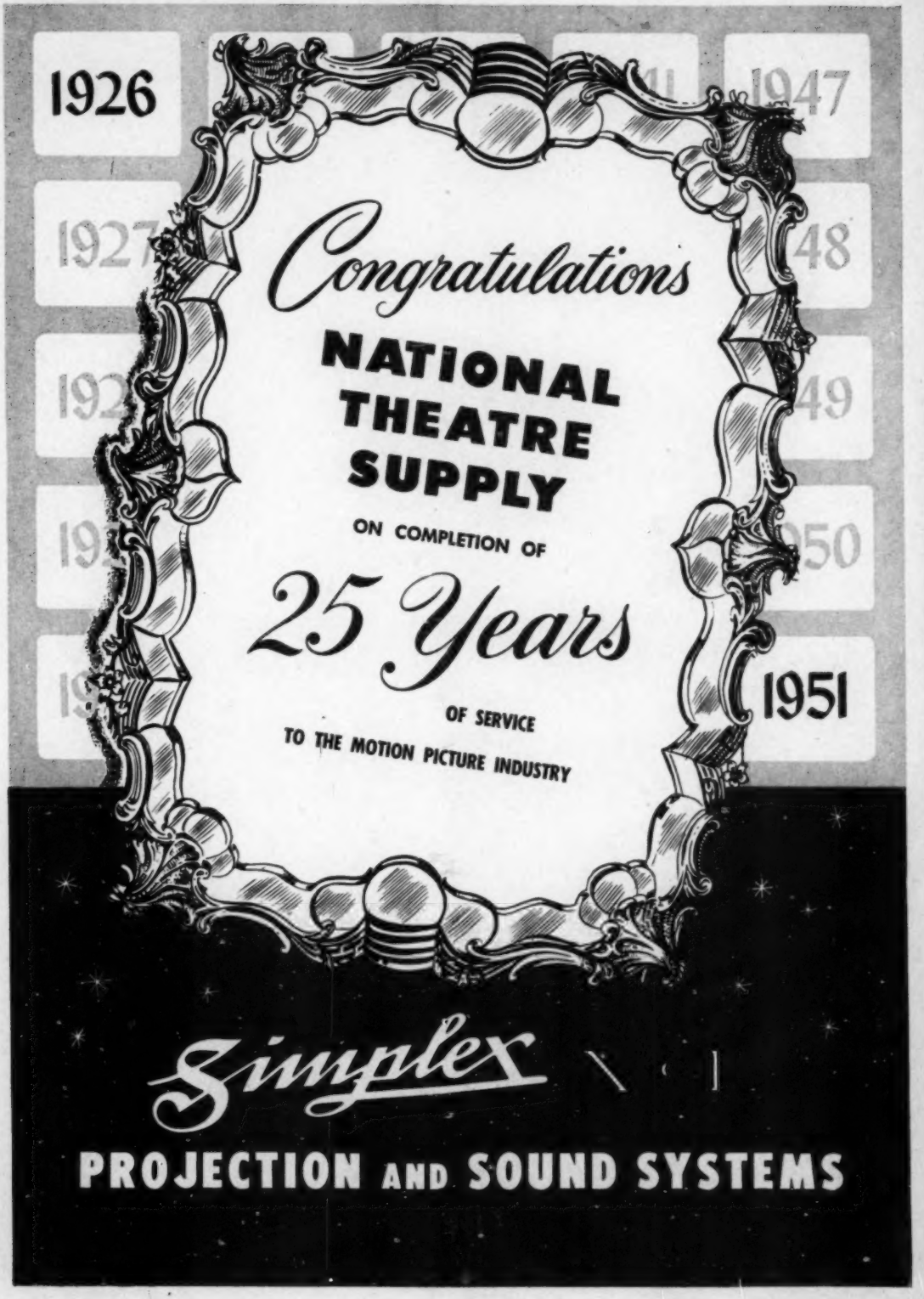
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